MODIS Snow-Mapping Efforts and Error Analysis

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THE DYNAMICS OF SNOW AND ICE COVER OVER LARGE AREAS AND RELATIONSHIPS TO SURFACE RADIATION BALANCE COMPONENTS AS OBSERVED BY MODIS

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OUTLINE

INTRODUCTION

BACKGROUND/CURRENTLY-AVAILABLE SNOW MAPS

SNOW COVER ALGORITHM RESULTS AND ERROR ANALYSIS

FIELD EXPERIMENTS AND FUTURE WORK

MODIS Snow Maps

- 7-day composite, global 1-km resolution, maximum weekly snow cover
- Some data also available at 500-m and 250-m resolution
- Will enable snow/cloud discrimination (e.g. band 6)
- Maps will be produced without operator intervention
- Statistics on snow-cover persistence will be developed for each grid cell

Specific Objective

To map the temporal and spatial variability of snow on hemispheric, continental and large-watershed scales

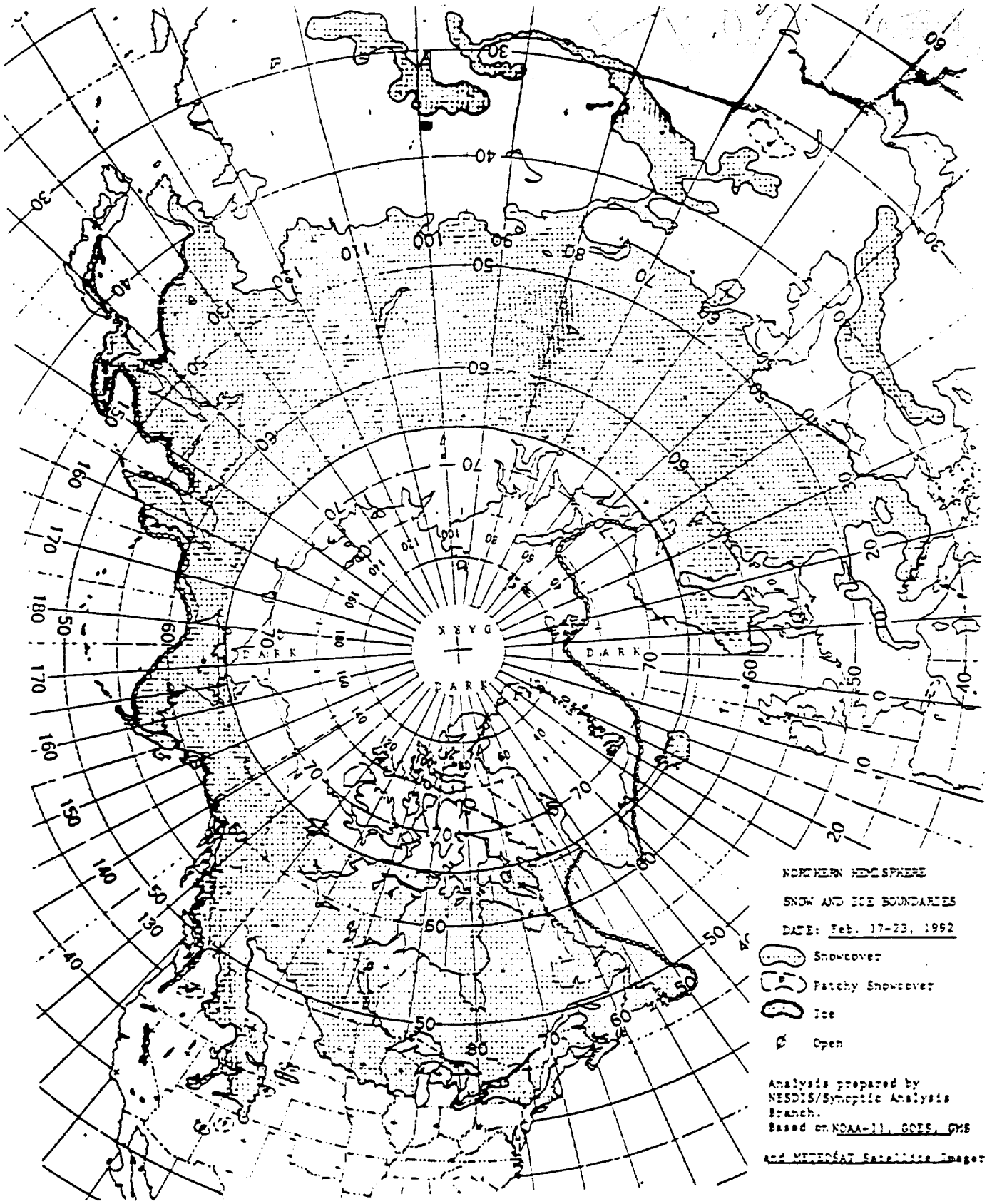
CURRENT SNOW COVER PRODUCTS

NOAA NORTHERN HEMISPHERE MAPS

NOHRSC RIVER BASIN-SCALE MAPS

SSMI PASSIVE-MICROWAVE GLOBAL-SCALE MAPS

TM / MSS RIVER BASIN-SCALE MAPS


NORTHERN HEMISPHERE
SNOW AND ICE BOUNDARIES
DATE: Feb. 17-23, 1992
Snowcover
Patchy Snowcover
Ice
Open
Analysis prepared by
NESDIS/Synoptic Analysis
Branch.
Based on NOAA-11, GOES, GMS
and METEOSAT Satellite Images
DARK
DARK
DARK

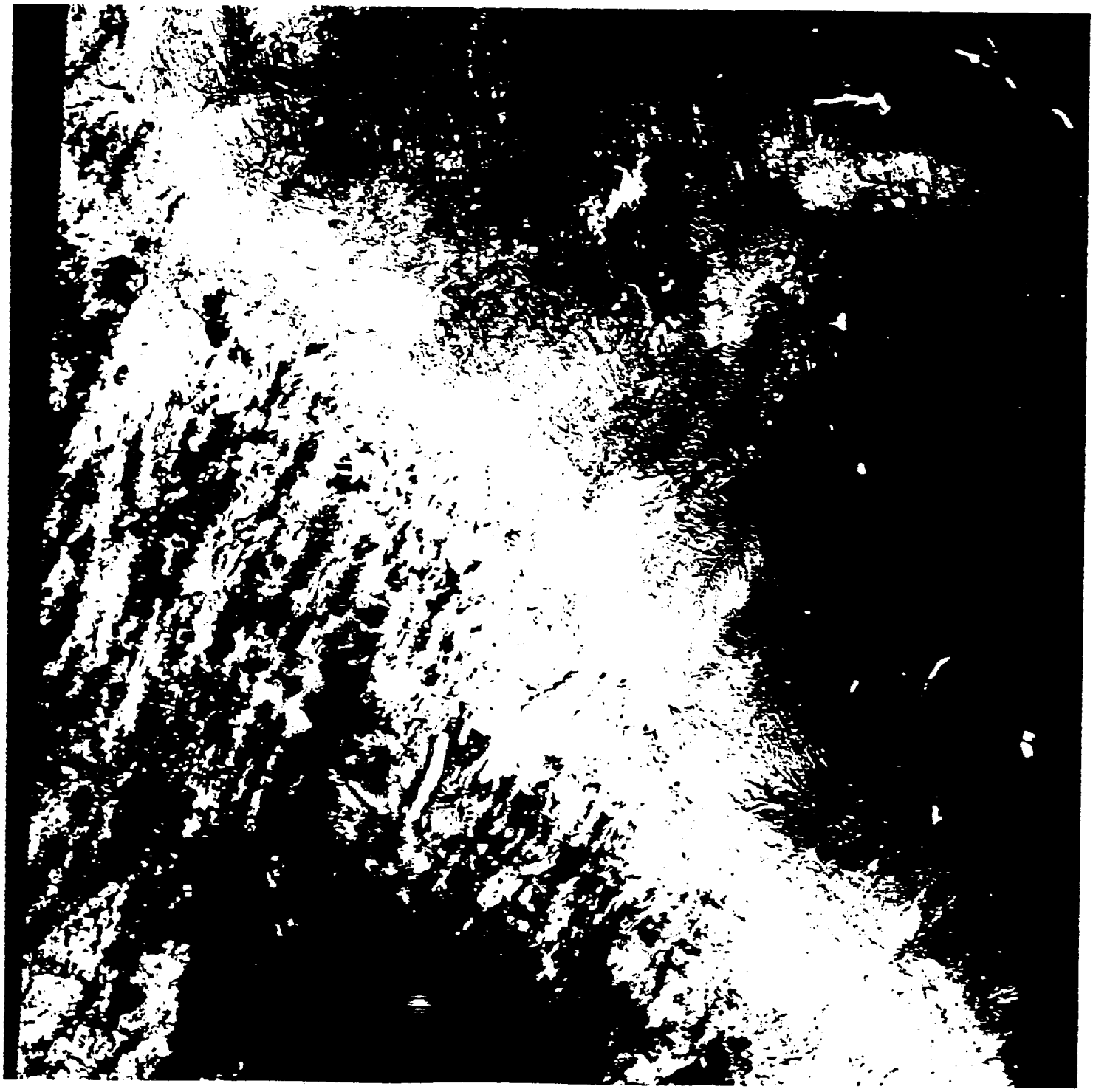
Difficulties in Satellite Snow Mapping

- Snow cannot be mapped through cloudcover and darkness using visible, near-IR and thermal IR data
- Snow-covered area is underestimated in mountainous terrain and in forested areas
- Snow/cloud discrimination is difficult using AVHRR data
- Landsat repeat cycle is only 16 days
- Passive MW sensors underestimate snow extent relative to visible, etc sensors

UTILITY OF SNOW MAPS

Global-scale maps are used to extend and improve snow-covered area estimates for climatological studies and as input to GCMs

Regional-scale maps are used as input to hydrological models to improve runoff prediction and are useful for predicting water supply and flooding



SNOMAP
Algorithm Development

SNOMAP utilizes visible and SWIR bands to separate snow and clouds, and to map snow

Normalized Difference Snow Index (NDSI) is used

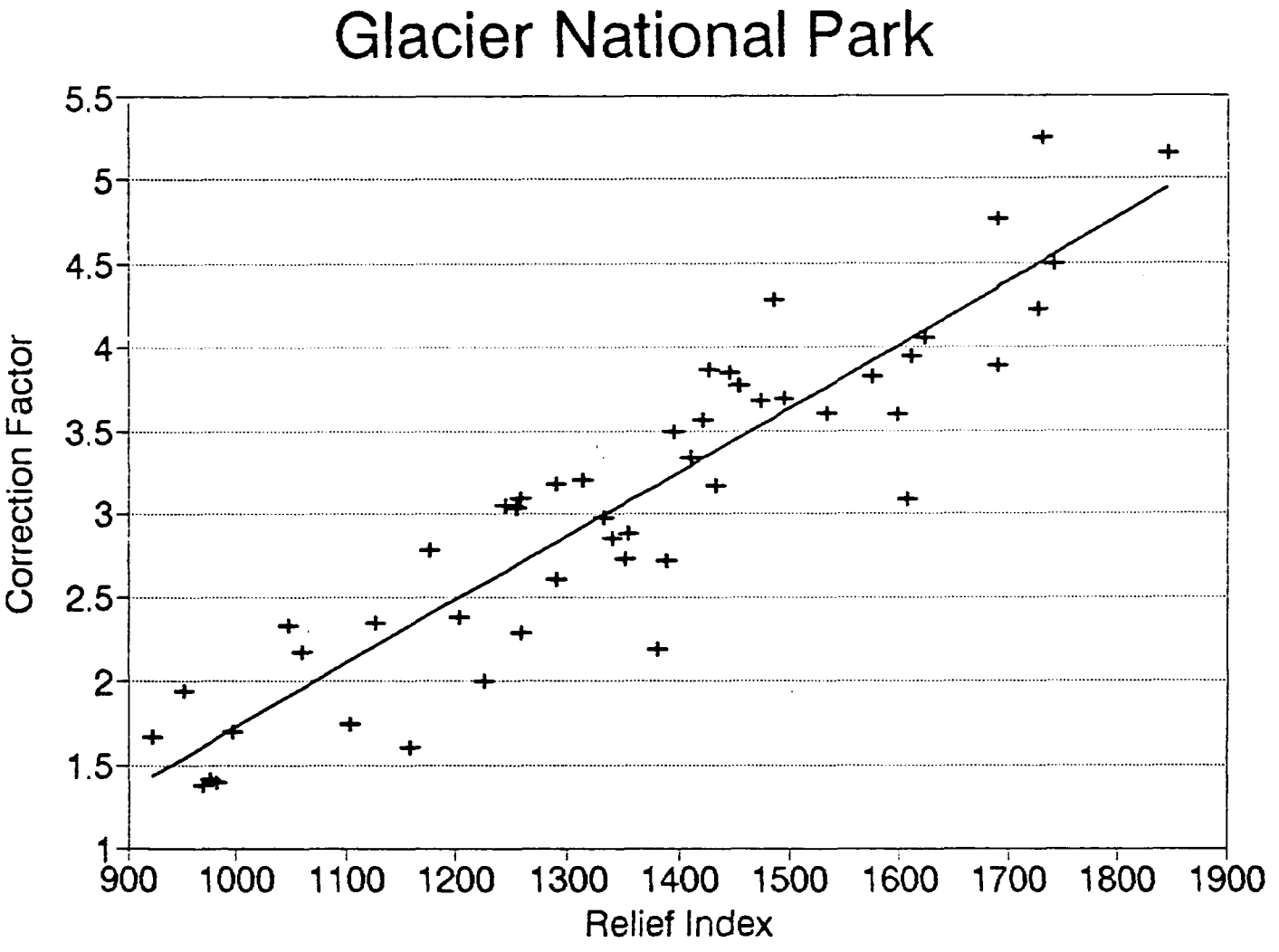
$$\frac{\text{TM2 (0.52 - 0.60 } \mu\text{m) - TM5 (1.55 - 1.75 } \mu\text{m)}}{\text{TM2 + TM5}}$$

and

TM4 (0.76 - 0.90 μm) reflectance > 11 percent

Heritage: Algorithm developed by Dozier (1989) to map snow in the Sierra Nevadas

For the prototype algorithm, Landsat TM DNs are converted to reflectance


Glacier National Park
Correction Factor
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
Relief Index

For a subscene of the 14 March 1991 TM scene, there is up to 5 times greater snow cover than is mapped using TM data alone

10 percent of the snow-covered areas in Glacier National Park are not mapped due to dense forests

Effects of topography on mapping snow-covered area globally using MODIS data are currently under investigation

In flatter areas, and areas with less dense vegetation, SNOMAP will map snow cover with far greater accuracy

Field and Aircraft Validation Efforts

MAS data acquired over Sierra Nevadas in Spring of 1991 and 1993

MAS and passive microwave data acquired over BOREAS test sites in February of 1994

Aircraft overflights simultaneous with a Landsat overpass on 6 March 1994 over Glacier National Park

Future Activities

- Spring 1995 MAC planned for central and northern Alaska (snow and sea ice)
- NOAA P-3 will fly FOCI mission in Bering Sea
- ER-2 MAS overflight will be requested
- Passive microwave sensors will be flown over snow and sea ice

CONCLUSIONS

MODIS snow maps will represent a substantial advancement due to improved spectral, spatial resolution, and ability to map snow automatically

Significant errors in measurement of actual snow-covered area (SCA) using satellite data are inherent in mountainous areas where actual SCA is underestimated

90 percent of the SCA is mapped under dense forests in Glacier National Park

Future activities will focus on error analysis and in refining the SNOMAP algorithm using MAS data